Advantages of PCI Audio Over ISA Audio

ISA based audio is inherently slow due to the 8 MHz DMA frequency of the ISA bus. During audio DMA transactions, the ISA bus stops the processor until the transaction has completed. PCI audio processing is up to 10 times faster. When audio is moved along the concurrent PCI bus, system resources (such as processor and memory) are available to process simultaneous transactions. This enables the processor to service high-bandwidth functions such as graphics while audio information is present on the PCI bus.

The ISA Bus Can Be An Audio Performance Bottleneck

The ISA bus supports a maximum data bandwidth of only 2 MB/s, whereas the PCI bus supports 100-plus MB/s. To highlight the bandwidth constraints of the ISA bus connection, the table below shows an example of the burden a consumer gaming application can impose by building several audio streams from simple (scenario 1) to complex (scenario 4).

Example: Audio-imposed ISA Bus Loads

Scenario	Audio Stream	Sample Form	Bits / Second	Percentage of System Overhead Consumed by ISA DMA
1	Speech	8 bit, 11 kHz, mono	88,200	2%
2	Sound effects	8 bit, 22 kHz, stereo	352,800	6%
3	Music	16 bit 44.1 kHz, stereo	1,411,200	24%
4	2 speech, 2 effects, music track	Several	2,293,200	38%

Consuming 38% of a system's performance for audio is not a viable solution. Multitasking operating systems might not perform well if audio consumes this much bandwidth. In this example, the 38% system overhead represents only a modest audio application. Imagine the considerable burden that a data-intensive, cutting-edge audio application would impose on the ISA bus. An example of this could be a gaming application that includes multiple players, multiple sound effects, audio streamed from the Internet, synthesized music for each scenario in the game, and one continuously running track played back as CD-quality audio. Given the 2 MB/s bandwidth constraints of the ISA bus, this type of application can only be made possible by moving the audio subsystem to the 100-plus MB/s PCI bus.

PCI Solves The High-Cost Of ISA Latency

Moving the audio subsystem from the ISA bus to the PCI bus decreases the bus bandwidth and system overhead consumed in the above gaming example from 38% on the ISA bus to less than 1% on the PCI bus. Connecting the audio subsystem to the PCI bus also solves the ISA bus latency problem.

Most sound cards include from two to four components comprising the wavetable synthesizer section of the product. Due to the high latency of the ISA bus, wavetable synthesizers on some sound cards require a local memory storage area, typically a ROM sized from 1 MB to 4 MB, for supplying these instrument recordings.

The PCI bus, with its associated bus mastering features, delivers low latency relative to the ISA bus. This allows a PCI-based audio subsystem to use main system memory for storing the instrument recordings.

PCI Facilitates Cooperative Signal Processing

For efficient system design, subsystems should cooperate and leverage associated resources. Cooperative signal processing describes partitioning the processing burdens for an audio subsystem between the host resources and the audio accelerator. The PCI bus facilitates this architecture. One example of the benefit of cooperative signal processing is streaming digital audio across the Internet, through the PCI bus and into system memory, while the audio accelerator post-processes that stream with audio effects like reverb.

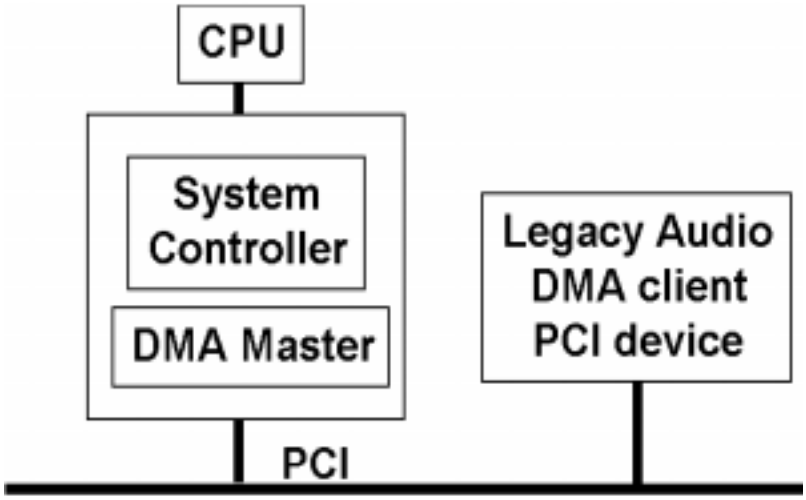
Legacy Audio Was A Barrier To Moving Audio To PCI

Game play is currently driving the evolution of several PC subsystems including graphics, video, and audio. Game play on PC platforms is in transition from DOS game products to Windows* game products. As backwards compatibility is required, audio subsystems must host game products for both DOS and Windows. DOS gaming audio requires SoundBlaster* compatibility, known as "legacy audio."

SoundBlaster games compatibility requires the ISA bus features of direct memory access (DMA) and interrupt request services (IRQs) to move audio content from memory and present it to the audio subsystem for processing. These DMA and IRQ services have until recently been entirely the province of the ISA bus, as the PCI bus did not support DMA or IRQ services.

Distributed DMA and serialized IRQs are available on the PCI bus. These enhancements to the PCI architecture, put in place by the Video Engineering Standards Association (VESA), allow for legacy audio compliance in PC audio subsystems. Audio subsystems tuned for this will bring the power of PCI combined with 100% DOS and SoundBlaster games' compatibility PC game play. The following table illustrates this envisioned upgrade to the PCI bus.

PCI's Distributed DMA and Serial IRQ Infrastructure



PCI Enables An Infinite Audio Palette

Moving the audio subsystem's connection point from ISA to PCI enables the creation of a sound palette of potentially infinite depth. Combining this sound palette with the building of a stable and consistent General MIDI sound set creates the foundation for a vastly improved wavetable synthesizer's instrument palette.

Summary

The two tables below summarize the pros and cons of ISA and PCI audio subsystems.

ISA Sound Configuration	
PROS	**CONS**
Low cost to implement	Low bandwidth limits audio functionality
Proven reliability	Uses precious IRQs and DMAs
Compatibility with Sound Blaster legacy applications	Limited to 85-dB signal-to-noise ratio

PCI Sound Configuration	
PROS	**CONS**
Higher bandwidth allows higher-quality audio effects (16 stereo streams, positional audio)	Higher initial cost to manufacturers
Less resource-intensive	SoundBlaster* compatibility must be implemented using a workaround
Allows 90-dB signal-to noise ratio or better	
Allows phaseout of ISA bus	

PCI Audio Reference Material

Audio Codec ’97 Component Specification
(http://developer.intel.com/pc-supp/platform/ac97/index.htm)

Implementing Legacy Audio on the PCI Bus, Revision 2.1
(http://www.intel.com/pc-supp/platform/ac97/wp/leg_pci.htm)

Intel Audio ’98 Roadmap, Revision 1.01
(http://developer.intel.com/pc-supp/platform/aud98/audio98.htm)

Digital Audio and the 1997 Desktop, Revision 1.01
(http://developer.intel.com/pc-supp/platform/ac97/wp/DIG_AUD.HTM)